REMARKS

Claims 1-26 are pending in this application. In the first Office Action, the Examiner rejected claims 1-26 under the judicially created doctrine of double patenting. The Examiner rejected claims 4-9 and 11-26 under 35 USC §102(b) as being anticipated by Collier, Jr. (US 6,506,720). The Examiner rejected claims 1-3 and 10 under 35 USC §103(a) as being unpatentable over Collier in view of design choice.

Reconsideration and re-examination of this application considering the following remarks is respectfully requested.

Obviousness-Type Double Patenting

The Examiner rejected all pending claims under the judicially created doctrine of obviousness-type double patenting relative to the parent application, now US Pat. No. 6,779,337 issued August 24, 2004. Applicants submit herewith a terminal disclaimer to obviate the Examiner's rejection.

Rejection Under 35 USC §102(b)

The Examiner rejected claims 4-9 and 11-26 under 35 USC §102(b) as being anticipated by US 6,506,720 to Collier, Jr. Applicants respectfully disagree and traverse the Examiner's rejection.

Applicants note that the priority date for the present application is September 20, 2002 and the issue date of the '720 reference relied upon by the Examiner is June 18, 2002 so that the rejection under §102(b) is improper. As such, Applicants assume for purposes of this response that the rejection is being made under 35 USC §102(a). Furthermore, Applicants have not made a determination as to whether the '720 reference is prior art relative to Applicants application and reserve the right to submit evidence establishing a prior date if applicable. As described in detail below, Applicants believe the present invention is patentable over the '720 reference and will assume, for purposes of this response, that the '720 reference is prior art under §102(a).

Collier, Jr. '720 is directed to a natural gas powered engine that uses natural gas as the primary fuel for the engine. A catalytic converter 14, which uses an oxidizing catalyst, is used to treat emissions, primarily CO. Collier discloses a system for "producing near-

zero NOx" but does not disclose a lean NOx trap as disclosed and claimed by Applicants. Rather, Collier produces near-zero NOx using charge dilution with exhaust gas (EGR) to lower peak combustion temperature (Col. 5, ll. 35-50). However, the amount of exhaust gas (charge dilution) required (30-50% as disclosed by Collier) to achieve near-zero NOx would normally result in misfires. Thus, Collier discloses adding a gas with wide flammability limits, such as hydrogen or carbon monoxide, to the fuel (natural gas) to eliminate misfires under heavy charge dilution. (Col. 5, ll.51-64) There is no disclosure of treating the exhaust using a catalyst to reduce NOx. (See also Col. 6, ll. 1-6; Col. 6, ll. 23-27; Col. 6, ll. 60-63; Col. 4, ll. 3-4, 8-9, 13-15, 29-33; etc.). Because the system of Collier produces near-zero NOx, there would be no need to treat the feedgas from the engine to reduce NOx.

The Examiner states that Collier discloses the use of a lean NOx trap (LNT) and purging of the LNT as claimed by Applicants. Applicants respectfully disagree. As noted above, Collier discloses the use of charge dilution to produce near-zero NOx and treats the exhaust using a catalyst to provide near-zero CO (Col. 5, l. 65 – Col. 6, l. 3). The catalyst can include platinum, palladium, rhodium or a mixture thereof (Col. 6, ll. 50-52). The engine is operated lean with equivalence ratios of 0.99 to 0.7 to provide excess oxygen between 0.5% and 4% to the catalyst. The catalyst reduces CO from 1000 ppm to less than 5 ppm (Col. 6, ll. 52-55). As evidenced by numerous patents in this art, those of ordinary skill in the art typically refer to this type of catalyst as a three-way catalyst (TWC), referring to its ability to convert hydrocarbons, (HC), NOx, and CO. However, the conversion efficiency for NOx is drastically reduced when operating lean (away from stoichiometry). As well-established in the art and clearly differentiated in Applicants' disclosure (See paragraph 022, for example), LNT's are a type of three-way catalyst specially formulated to store NOx when operating lean (equivalence ratios less than unity), but require periodic "purging" using a reductant (not an oxidant). As disclosed in the present application, the reductant may be provided directly to the catalyst by a dedicated injector (paragraph 021), or may be provided indirectly through the exhaust stream by operating rich (equivalence ratios greater than unity) (See paragraphs 026. 029). Because Collier does not disclose the use of a LNT, there is no disclosure of periodically purging the LNT by providing a reductant as disclosed and claimed by Applicants. In fact, Collier

does not disclose operating rich for any reason. Note that all the equivalence ratios disclosed by Collier are less than unity (lean). (See Col. 6, ll. 20-26, Figs. 2-3)

In addition to the above-described distinguishing characteristics, Applicants' invention as disclosed and claimed is fundamentally different in principle from that disclosed by Collier. As described above, Collier adds hydrogen (or CO) to the fuel (natural gas) to increase flammability limits because of heavy charge dilution (30-50% EGR), which is added to produce near-zero NOx. In contrast, Applicants' invention is directed to an engine that uses hydrogen as its fuel, not an additive. This allows operation under very lean equivalence ratios (0.15-0.65) with little or no EGR. However, the use of little or no EGR coupled with the high flame speed of hydrogen, produces more feedgas NOx, which is stored in the LNT until periodically being purged. As described in paragraphs 005-006, the extremely lean flammability limit and high flame speed of hydrogen can result in auto ignition, which is self-ignition of the fuel before a spark is provided by the spark plug. Auto ignition is essentially the opposite of the misfire condition described by Collier, which results when the charge is too lean and does not ignite properly when the spark is provided. As such, Collier adds between 20% and 60% hydrogen to increase the flammability limit and provide stable combustion. In contrast, during purging of the LNT or under full load where equivalence ratios approach or exceed unity, Applicants' invention uses charge dilution (40-80% EGR) to decrease flammability limits of the hydrogen-air charge to avoid auto ignition and to lower combustion temperature while maintaining stable combustion.

With respect to claim 4, Applicants claim providing premixed air and hydrogen at an equivalence ratio of air and hydrogen of approximately unity. In contrast, Collier discloses equivalence ratios of air and gaseous fuel, which is natural gas with 20%-60% hydrogen. Collier does not disclose providing air and hydrogen as disclosed and claimed. Furthermore, there would be no motivation for one of ordinary skill in the art to modify the charge as disclosed by Collier to provide an equivalence ratio of air and hydrogen as disclosed and claimed by Applicants. As described above, the system disclosed in Collier '720 is directed to solving a different problem, i.e. to increasing flammability to reduce misfire, not to decreasing flammability to reduce auto ignition. The range of equivalence ratios is not merely a design choice or obvious in light of Collier '720 due to the unique characteristics of hydrogen used as the primary fuel as recognized by Applicants and

discussed in the specification in paragraphs 005-006, for example. As such, Applicants respectfully submit that the invention as claimed in Claim 4 distinguishes over Collier '720 and requests that the rejection be withdrawn.

Regarding claims 5, 9, 11, 12, 13, 15, 16, 17, 25, and 26 , the Examiner has restated each claim and cited Col. 5, ll. 17-67; col. 6, ll. 1-67 of Collier as disclosing that element. Applicants have carefully reviewed the cited columns and do not find where these claimed elements are disclosed. As such, the Examiner is respectfully requested to provide a more specific indication of where the Examiner contends that Collier '720 discloses: that EGR includes residual exhaust gases trapped in the cylinder; a lean NOx trap (LNT); purging of any type of catalyst (but specifically a LNT); a determination of when to purge; operation at equivalence ratios greater than unity (rich); supplying hydrogen in response to a purge determination; supplying hydrogen downstream of the combustion chamber during purging; an injector for providing hydrogen downstream of the engine; and increasing EGR to reduce auto ignition during purging. Applicants respectfully submit that these features are neither disclosed nor suggested by Collier '720.

Similarly, with respect to claims 19-23, the Examiner recites a claim limitation and states that Collier discloses the limitation in Col. 7, ll. 14-42. Applicants respectfully request a more specific indication of where each element is disclosed. Collier '720 does not appear to disclose operation at equivalence ratios greater than unity under any conditions, much less after determining when to purge an LNT.

For the reasons stated above, Applicants respectfully submit that the invention as claimed in claims 4-9 and 11-26 is patentable over Collier '720 and request that the rejection be withdrawn.

Rejection under 35 USC §103(a)

The Examiner rejected claims 1-3 and 10 as being unpatentable over Collier '720 in view of design choice. As described above, Collier '720 does not disclose a lean NOx trap, purging of a LNT, when to purge a LNT, or how to purge a LNT. There is no disclosure or suggestion in Collier '720 to operate at stoichiometry (equivalence ratio of unity) or rich (equivalence ratios greater than unity). Because Collier does not use hydrogen as a primary fuel, Collier does not recognize the problems associated with using hydrogen as a primary fuel as recognized and solved by Applicants' claimed invention.

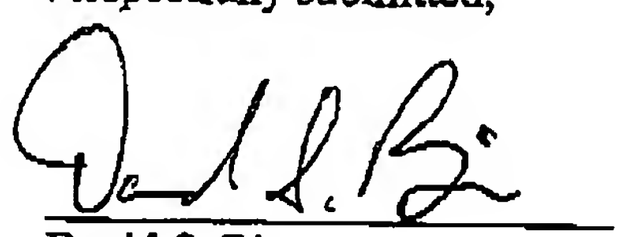
The only catalyst disclosed by Collier is used to treat CO and requires that the engine be operated lean, not rich as disclosed and claimed by Applicants. As such there would be no motivation for one of ordinary skill in the art to modify the disclosure of Collier to operate rich to purge the catalyst even if one were to consider the oxidizing catalyst disclosed by Collier equivalent to a NOx trap disclosed by Applicants (which it is not).

Summary

Applicants have made a genuine effort to respond to the Examiner's rejection and advance prosecution of this application. Applicants believe all formal and substantive requirements for patentability have been met and that this application is in condition for allowance, which action is respectfully requested. No additional fee is believed to be due as a result of the filing of this paper. A separate authorization is provided for filing the enclosed Terminal Disclaimer on that document. Please charge Deposit Account 06-1510 (Ford Global Technologies, LLC) for any required fee(s) as authorized by the original transmittal letter in this application.

The Examiner is requested to telephone the undersigned to discuss any remaining issues or requirements that may be necessary.

Respectfully submitted,



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Enclosure: Terminal Disclaimer

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